(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 913 346 A1**

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
24.11.2021 Bulletin 2021/47

(21) Application number: **20175432.2**

(22) Date of filing: **19.05.2020**

(51) Int Cl.:
G01M 3/28 *(2006.01)* ***G01M 3/00*** *(2006.01)*
G01F 1/684 (2006.01)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(54) **METHOD AND APPARATUS FOR MICRO-LEAKAGE DETECTION IN A FLUID SYSTEM**

(57) Method for micro-leakage detection in a fluid system (10), especially in a potable water system installed in a building (11), wherein the fluid system (10) has a fluid pipe (12) with a fluid valve (14), wherein a fluid flow through the fluid pipe (12) is stopped when the fluid valve (14) is closed, and wherein a fluid flow through the fluid pipe (12) is allowed when the fluid valve (14) is opened. The method comprises the following steps: Measuring the fluid flow through the fluid pipe (12) by a flow meter (16). Measuring the pipe temperature of the fluid pipe (12) by at least one pipe temperature sensor (17a, 17b). When there is no fluid flow measured by the flow meter (16), analyzing the pipe temperature for the micro-leakage detection.

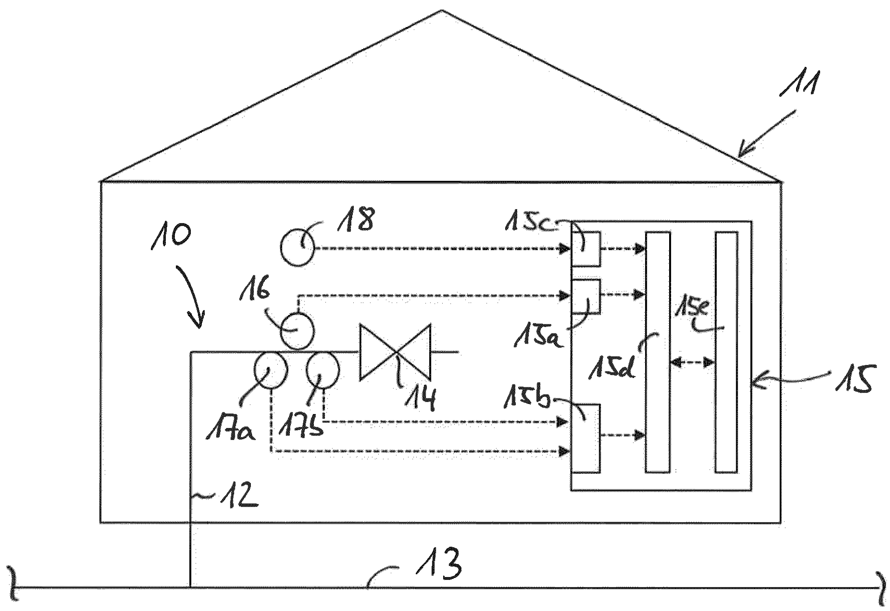

Fig.1

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Description

[0001] The invention relates to a method for micro-leakage detection in a fluid system. Further on, the invention relates to an apparatus for micro-leakage detection in a fluid system

[0002] US 2019/0128762 A1 discloses an apparatus for fluid flow detection. The apparatus makes use of a signal provided by a pipe temperature sensor and of a signal provided by an ambient temperature sensor. A low flow algorithm may attempt to detect flow leaks such as a dripping tap. If no leak is present during a quiet period, the ambient temperature and pipe temperature will generally tend to be close together. If, on the other hand, a low flow leak is present during a quiet period, there will be generally a noticeable difference between the ambient temperature and pipe temperature.

[0003] US 10 527 516 B2 and JP 6 611 650 B2 disclose other prior art.

[0004] Against this background, a novel method and apparatus for micro-leakage detection in a fluid system is provided.

[0005] The novel method for micro-leakage detection in a fluid system comprises at least the following steps: Measure the fluid flow through a fluid pipe by a flow meter.

[0006] Measure the pipe temperature of the fluid pipe by at least one pipe temperature sensor.

[0007] When there is no fluid flow measured by the flow meter, analyze the pipe temperature for the micro-leakage detection.

[0008] The novel method for micro-leakage detection is based both on a flow measurement by a flow meter and a pipe temperature measurement by the at least one pipe temperature sensor. The novel method allows a very simple and reliable micro-leakage detection in a fluid system.

[0009] According to a first embodiment of the method for micro-leakage detection the same has the additional following steps: When there is no fluid flow measured by the flow meter after the fluid flow through the fluid pipe has been stopped, calculate a temporal gradient of the pipe temperature. If the temporal gradient of the pipe temperature differs more than a first threshold from a first reference value, and if there is no flow measured by the flow meter, then detect micro-leakage.

[0010] According to a second embodiment of the method for micro-leakage detection the same has the additional following steps: Measure the pipe temperature of the fluid pipe by a first pipe temperature sensor and by a second pipe temperature sensor being positioned at different locations of the fluid pipe. When there is no fluid flow measured by the flow meter for the defined time interval, calculate a difference between the pipe temperatures measured by the first and second pipe temperature sensors. If the difference between the pipe temperatures differs more than a second threshold from a second reference value, and if there is no flow measured by the flow meter, then detect micro-leakage.

[0011] The above first and second embodiments are preferred. The same do not require the measurement of the ambient temperature. Such an ambient temperature independent micro-leakage detection is very simple and reliable. It is possible to use the first and second embodiment in combination, meaning that micro-leakage is detected if the temporal gradient of the pipe temperature differs more than the first threshold from the first reference value and/or if the difference between the pipe temperatures differs more than the second threshold from the second reference value.

[0012] The novel apparatus for micro-leakage detection in a fluid system is defined in claim 15.

[0013] Preferred developments of the invention are provided by the dependent claims and the description which follows. Exemplary embodiments are explained in more detail on the basis of the drawing, in which:

Figure 1	shows a schematic diagram of a fluid flow system;
Figure 2	shows a signal flow diagram illustrating a first embodiment;
Figure 3	shows a signal flow diagram illustrating a second embodiment;
Figure 4	shows a signal flow diagram illustrating a third embodiment,
Figure 5	shows a time diagram further illustrating the first embodiment,
Figure 6	shows a time diagram further illustrating the second embodiment,
Figure 7	shows a time diagram further illustrating the third embodiment.

[0014] Figure 1 shows a schematic diagram of a fluid flow system 10, namely of a potable water system, of a building 11. The fluid flow system 10 comprises a fluid pipe 12 running at least partially inside of the building 11. This fluid pipe 12 is connected to a main water pipe 13 running outside of the building 11. This fluid pipe 12 comprises a fluid valve 14. The fluid valve 14 may be a water tap. A fluid flow through the fluid pipe 12 is stopped when the fluid valve 14 is closed. A fluid flow through the fluid pipe 12 is allowed when the fluid valve 14 is opened. The fluid pipe 12 may be made from a metal like copper or from a plastic like polypropylene.

[0015] The present invention relates to a method and apparatus for micro-leakage detection in the fluid system 10. Figure 1 shows such an apparatus 15 for micro-leakage detection.

[0016] The apparatus 15 receives at least signals from a flow meter 16 and from at least one pipe temperature sensor 17a, 17b. The flow meter 16 is assigned to the fluid pipe 12 and measures the fluid flow through the fluid pipe 12. The at least one pipe temperature sensor 17a, 17b is also assigned to the fluid pipe 12 and measures the pipe temperature of the fluid pipe 12.

[0017] Figure 1 shows a first pipe temperature sensor 17a and a second pipe temperature sensor 17b. Further,

Figure 1 shows an ambient temperature sensor 18 measuring an ambient temperature within the building. The ambient temperature sensor 18 may be positioned in the proximity of the fluid pipe 12. Only one of the first and second temperature sensors 17a, 17b and the flow meter 16 are mandatory units for the present invention. The ambient temperature sensor 18 is an optional unit. If an ambient temperature sensor 18 is present, the same is preferably positioned in the proximity of the fluid pipe 12.

[0018] A first embodiment of the invention makes use of at least one pipe temperature sensor 17a, 17b and of the flow meter 16 only.

[0019] A second embodiment of the invention makes use of the first and second pipe temperature sensors 17a and 17b and of the flow meter 16.

[0020] The apparatus 15 for micro-leakage detection has an interface 15a being configured to receive signals or data from the flow meter 16 and an interface 15b being configured to receive signals or data from the at least one pipe temperature sensor 17.

[0021] A third embodiment makes use of at least one pipe temperature sensor 17a, 17b, of the flow meter 16 and of the ambient temperature sensor 18. In this case the apparatus 15 for micro-leakage detection has an interface 15c being configured to receive signals or data from the ambient temperature sensor 18.

[0022] The method for micro-leakage detection in the fluid system 10 comprises at least the following steps: Measure the fluid flow through the fluid pipe 12 by the flow meter 16.

[0023] Measure the pipe temperature of the fluid pipe 12 by at least one pipe temperature sensor 17a, 17b.

[0024] When there is no fluid flow measured by the flow meter 13, analyze the pipe temperature for the micro-leakage detection.

[0025] The method for micro-leakage detection is based both on a flow measurement by the flow meter 16 and pipe temperature measurement by the at least one pipe temperature sensor 17a, 17b. The method allows a very simple and reliable micro-leakage detection in the fluid system 10.

[0026] The apparatus 15 is configured to execute the above method steps. The interface 15a of the apparatus 15 is configured to receive signals or data from the flow meter 16 measuring the fluid flow through the fluid pipe 12. The interface 15b of the apparatus 15 is configured to receive signals or data from the at least one pipe temperature sensor 17a, 17b measuring the pipe temperature of the fluid pipe 12. A processor 15d of the apparatus 15 is configured to detect micro-leakage by analyzing the pipe temperature provided by the at least one pipe temperature sensor 17a, 17b when there is no fluid flow measured by the flow meter 16. The apparatus 15 further comprises a memory 15e.

[0027] As mentioned above, a first embodiment of the invention makes use of at least one pipe temperature sensor 17a and/or 17b and of the flow meter 16 only. In the following description of the first embodiment it is presumed that the pipe temperature sensor 17a is used for the measurement of the pipe temperature.

[0028] In this first embodiment a temporal gradient of the pipe temperature measured by the pipe temperature sensor 17a is calculated when there is no fluid flow measured by the flow meter 16 after the fluid flow through the fluid pipe 12 has been stopped.

[0029] The temporal gradient is also often called gradient over time. If the temporal gradient of the pipe temperature differs more than a first threshold from a first reference value, and if there is no flow measured by the flow meter 16, then micro-leakage is detected.

[0030] Figure 2 shows a signal flow diagram for the first embodiment of the invention.

[0031] In step 20 the flow meter 16 measures the fluid flow though the fluid pipe 12. In step 21 the pipe temperature sensor 17a measures the pipe temperature of the fluid pipe 12.

[0032] In step 22 it is determined if the flow meter 16 measures a fluid flow through the fluid pipe 12. If it is determined in step 22 that the flow meter 16 measures a fluid flow through the fluid pipe 12, then the method goes back to step 20. If it is determined in step 22 that the flow meter 16 measures no fluid flow through the fluid pipe 12, then the method goes to step 23.

[0033] In step 23 is determined if the flow meter 16 measures no fluid flow through the pipe. If this is not the case, the method goes back to step 20. If this is the case, the method goes to step 24. In step 24 the temporal gradient - also often called gradient over time - of the pipe temperature measured by the pipe temperature sensor 17a is calculated.

[0034] Then, in step 25 it is determined if the temporal gradient of the pipe temperature differs more than a first threshold from a first reference value or not.

[0035] If the temporal gradient of the pipe temperature does not differ more than the first threshold from the first reference value, no micro-leakage is detected in step 26. If the temporal gradient of the pipe temperature differs more than the first threshold from the first reference value, and if there is still no fluid flow measured by the flow meter 16, then in step 27 micro-leakage is detected.

[0036] In connection with the first embodiment, alternatively the pipe temperature sensor 17b may be used for the measurement of the pipe temperature. Further on, both pipe temperature sensors 17a, 17b may be used and an average value may be calculated for the pipe temperature.

[0037] The first reference value for the temporal gradient of the pipe temperature may be determined as follows: If there is no fluid flow measured after the fluid flow through the fluid pipe has been stopped, then calculate and store the temporal gradient of the pipe temperature. Calculate an average value from the stored temporal gradients. Determine the first threshold from this average value.

[0038] The average value may be multiplied by a security-factor to determine the first reference value. The calculated temporal gradient may only be stored and used to calculate the average value if the calculated temporal gradient is within a range around a previously calculated temporal gradient or within a range around an average value of previously stored temporal gradients.

[0039] Figure 5 shows a time diagram further illustrating the first embodiment of the invention. Figure 5 shows as a function of the time t a fluid flow rate 50 and a pipe temperature 51 measured by the pipe temperature sensor 17a.

[0040] At point of times t1, t3 and t5 a respective fluid flow 50 through the fluid pipe 12 starts. At point of times t2, t4 and t6 the respective fluid flow 50 through the fluid pipe 12 stops.

[0041] After the fluid flow through the fluid pipe 12 has been stopped at the point of times t2, t4 and t6, the temporal gradient 52 of the pipe temperature 51 is calculated. If the calculated temporal gradient 52 of the pipe temperature 51 differs more than the first threshold from the first reference value, and if there is no flow measured by the flow meter 16, then micro-leakage is detected.

[0042] In Figure 5, the temporal gradients 52 calculated at point of times t2, t4 do not differ more than the first threshold from the first reference value. So, no micro-leakage is detected at point of times t2, t4. The temporal gradient 52 calculated at point of times t6 differs more than the first threshold from the first reference value. So, micro-leakage 53 is detected at point of times t6. The first reference value may correspond to the average of the temporal gradients 52 calculated at point of times t2, t4.

[0043] As mentioned above, a second embodiment of the invention makes use of the first and second pipe temperature sensors 17a, 17b and of the flow meter 16.

[0044] In this second embodiment the pipe temperature of the fluid pipe 12 is measured by the first pipe temperature sensor 17a and by the second pipe temperature sensor 17b being positioned at different locations of the fluid pipe 12. The pipe temperature sensors 17a and 17b have a different distance to the fluid valve 14. The pipe temperature sensor 17b is positioned closer to the fluid valve 14 than the pipe temperature sensor 17a. The distance between the pipe temperature sensors 17a and 17b may be at least 20 cm.

[0045] When there is no fluid flow measured by the flow meter 16 for a defined time interval, a difference between the pipe temperatures measured by the first and second pipe temperature sensors 17a and 17b is calculated. If the difference between these pipe temperatures differs more than a second threshold from a second first reference value, and if there is no flow measured by the flow meter 16, then micro-leakage is detected.

[0046] Figure 3 shows a signal flow diagram for the second embodiment of the invention.

[0047] In step 30 the flow meter 16 measures the fluid flow though the fluid pipe 12. In step 31 the first pipe temperature sensor 17a measures the pipe temperature of the fluid pipe 12. In step 32 the second pipe temperature sensor 17b measures the pipe temperature of the fluid pipe 12.

[0048] In step 33 it is determined if the flow meter 16 measures no fluid flow through the pipe. If this is not the case, the method goes back to step 30. If this is the case, the method goes to step 34.

[0049] In step 34 it is determined if the flow meter 16 measured no fluid flow through the fluid pipe 12 for a defined time interval. If this is not the case, the method goes back to step 30. If this is the case, the method goes to step 35.

[0050] In step 35 the temperature difference between the pipe temperatures measured by the first and second pipe temperature sensors 17a and 17b is calculated.

[0051] Then, in step 36 it is determined if this temperature difference differs more than a second threshold from the second reference value or not.

[0052] If this temperature difference does not differ more than the second threshold from the second reference value, no micro-leakage is detected in step 37.

[0053] If this temperature difference differs more than the second threshold from the second reference value, and if there is still no fluid flow measured by the flow meter 16, then in step 38 micro-leakage is detected.

[0054] The second reference value is determined as follows: If there is no fluid flow measured for the defined time interval, then calculate and store the difference between the pipe temperatures measured by the first and second pipe temperature sensors 17a, 17b. Calculate an average value from the stored differences Determine the second threshold from this average value.

[0055] The average value may be multiplied by a security-factor to determine the second reference value. The calculated difference may only be stored and used to calculate the average value if the calculated difference is within a range around a previously calculated difference or within a range around an average value of previously stored differences.

[0056] Figure 6 shows a time diagram further illustrating the second embodiment of the invention. Figure 6 shows as a function of the time t a fluid flow rate 60 and pipe temperatures 62, 63 measured by the pipe temperature sensors 17a, 17b.

[0057] At point of times t1, t3 and t5 a respective fluid flow 60 through the fluid pipe 12 starts. At point of times t2, t4 and t6 the respective fluid flow 60 through the fluid pipe 12 stops.

[0058] When there is no fluid flow measured by the flow meter 16 for a defined time interval after the fluid flow through the fluid pipe 12 has been stopped at the point of times t2, t4 and t6, a temperature difference 63 between the pipe temperatures 61, 62 measured by the first and second pipe temperature sensors 17a, 17b is calculated.

[0059] If the temperature difference 63 between the pipe temperatures 61, 62 differs more than the second threshold from the second reference value, and if there is no flow measured by the flow meter 16, then micro-leakage 64 is detected.

[0060] In Figure 6, the temperature differences 63 calculated a defined time interval after the point of times t2, t4 do not differ more than the second threshold from the second reference value. So, no micro-leakage is detected. The temperature difference 63 calculated a defined time interval after the point of time t6 differs more than the second threshold from the second reference value. So, micro-leakage 64 is detected. The second reference value may correspond to the average of the temperature differences 63 calculated the defined time interval after the point of times t2, t4.

[0061] The above first and second embodiments are preferred. The same do not require the measurement of the ambient temperature. Such an ambient temperature independent micro-leakage detection is very simple and reliable.

[0062] It is possible to use the first and second embodiment in combination. So, micro-leakage may be detected if the temporal gradient of the pipe temperature differs more than the first threshold from the first reference value or if the difference between the pipe temperatures differs more than the second threshold from the second reference value.

[0063] A third embodiment makes use of the ambient temperature sensor 18.

[0064] In this third embodiment, the ambient temperature is measured by the ambient temperature sensor 18. When there is no fluid flow measured by the flow meter 16 for a defined time interval, then a difference between the pipe temperature and the ambient temperature is calculated. If the difference between the pipe temperature and the ambient temperature differs more than a third threshold from a third reference value, and if there is still no flow measured by the flow meter 16, then micro-leakage is detected.

[0065] Figure 4 shows a signal flow diagram for the third embodiment of the invention.

[0066] In step 40 the flow meter 16 measures the fluid flow though the fluid pipe 12. In step 41 at least one of pipe temperature sensors 17a, 17b measures the pipe temperature. In step 42 the ambient temperature sensor 18 measures the ambient temperature.

[0067] In step 43 it is determined if the flow meter 16 measures no fluid flow through the fluid pipe 12. If this is not the case, the method goes back to step 40. If this is the case, the method goes to step 44.

[0068] In step 44 it is determined if the flow meter 16 measured no fluid flow through the fluid pipe 12 for a defined time interval. If this is not the case, the method goes back to step 40. If this is the case, the method goes to step 45.

[0069] In step 45 the temperature difference between the pipe temperature measured by the respective pipe temperature sensor 17a, 17b and the ambient temperature measured by the ambient temperature sensor 18 is calculated.

[0070] Then, in step 46 it is determined if this temperature difference differs more than a third threshold from the third reference value or not.

[0071] If this temperature difference does not differ more than the third threshold from the third reference value, no micro-leakage is detected in step 46.

[0072] If this temperature difference differs more than the third threshold from a third reference value, and if there is still no fluid flow measured by the flow meter 16, then in step 47 micro-leakage is detected.

[0073] The third threshold for the difference between the pipe temperature and the ambient temperature may be determined as follows: If there is no fluid flow measured for the defined time interval, then calculate and store the difference between the pipe temperature and the ambient temperature. Calculate an average value from the stored differences. Determine the first threshold from this average value. The average value may be multiplied by a factor to determine the third reference value. The calculated difference may only ce stored and used to calculate the average value if the calculated difference is within a range around a previously calculated difference or within a range around an average value of previously stored differences.

[0074] Figure 7 shows a time diagram further illustrating the third embodiment of the invention. Figure 7 shows as a function of the time t a fluid flow rate 70 and a temperature difference 71 between the pipe temperature measured by one of the pipe temperature sensors 17a, 17b and the ambient temperature.

[0075] At point of times t1, t3 and t5 a respective fluid flow 70 through the fluid pipe 12 starts. At point of times t2, t4 and t6 the respective fluid flow 70 through the fluid pipe 12 stops. When there is no fluid flow measured by the flow meter 16 for a defined time interval after the fluid flow through the fluid pipe 12 has been stopped at the point of times t2, t4 and t6, the temperature difference 71 is determined. If the temperature difference 71 between the pipe temperature and the ambient temperature differs more than the third threshold from the third reference value, and if there is no flow measured by the flow meter 16, then micro-leakage 73 is detected.

[0076] In Figure 7, the values V1, V2 of temperature difference 71 determined a defined time interval after the point of times t2, t4 do not differ more than the third threshold from the third reference value. So, no micro-leakage is detected. The value V3 of the temperature difference 71 determined a defined time interval after the point of time t6 differs more than the third threshold from the third reference value. So, micro-leakage 72 is detected. The third reference value may correspond to the average of the temperature difference values V1, V2 calculated the defined time interval after the point of times t2, t4.

[0077] It is possible to use the third embodiment in combination with the first and/or second embodiment. So, micro-leakage may be detected if the temporal gradient of the pipe temperature differs more than the first threshold from the first reference value or if the difference between the pipe temperature and the ambient temperature differs more than the third threshold from the third reference value. Further on, micro-leakage may be detected if the difference between the two pipe temperatures differs more than the second threshold from the second reference value or if the difference between the pipe temperature and the ambient temperature differs more than the third threshold from the third reference value.

[0078] The invention allows micro-leakage detection in the magnitude of less than 1 liter per hour.

List of reference signs

[0079]

10	fluid flow system
11	building
12	fluid pipe
13	main water pipe
14	fluid valve
15	apparatus
15a	interface
15b	interface
15c	interface
15d	processor
15e	memory
16	flow meter
17a	pipe temperature sensor
17b	pipe temperature sensor
18	ambient temperature sensor
20	step
21	step
22	step
23	step
24	step
25	step
26	step
27	step
30	step
31	step
32	step
33	step
34	step
35	step
36	step
37	step
38	step
40	step
41	step
42	step
43	step
44	step
45	step
46	step
47	step
48	step
50	fluid flow rate
51	pipe temperature
52	temporal gradient
53	micro-leakage
60	fluid flow rate
61	pipe temperature
62	pipe temperature
63	temperature difference
64	micro-leakage
70	fluid flow rate
71	temperature difference
72	micro-leakage

Claims

1. Method for micro-leakage detection in a fluid system (10), especially in a potable water system installed in a building (11),

    wherein the fluid system (10) has a fluid pipe (12) with a fluid valve (14),
    wherein a fluid flow through the fluid pipe (12) is stopped when the fluid valve (14) is closed, and
    wherein a fluid flow through the fluid pipe (12) is allowed when the fluid valve (14) is opened,

    the method comprising the following steps:

    measuring the fluid flow through the fluid pipe (12) by a flow meter (16),
    measuring the pipe temperature of the fluid pipe (12) by at least one pipe temperature sensor (17a, 17b),
    when there is no fluid flow measured by the flow meter (16), analyzing the pipe temperature for the micro-leakage detection.

2. Method as claimed in claim 1, **characterized by** the following steps:

    when there is no fluid flow measured by the flow meter (16) after the fluid flow through the fluid pipe (12) has been stopped, calculating a temporal gradient of the pipe temperature,
    if the calculated temporal gradient of the pipe temperature differs more than a first threshold from a first reference value, and if there is no flow measured by the flow meter (16), then detect micro-leakage.

3. Method as claimed in claim 2, **characterized in that** the first reference value is determined as follows:

    if there is no fluid flow measured after the fluid flow has been stopped, then calculate and store the temporal gradient of the pipe temperature,
    calculate an average value from the stored temporal gradients,

determine the first threshold from this average value.

4. Method as claimed in claim 3, **characterized in that** the calculated temporal gradient is only stored and used to calculate the average value if the calculated temporal gradient is within a range around a previously calculated temporal gradient or within a range around an average value of previously stored temporal gradients.

5. Method as claimed in claim 3 or 4, **characterized in that** the average value is multiplied by a factor to determine the first reference value.

6. Method as claimed in one of claims 1 to 5, **characterized by** the following steps:

measuring the pipe temperature of the fluid pipe (12) by a first pipe temperature sensor (17a) and by a second pipe temperature sensor (17b) being positioned at different locations of the fluid pipe (12),
when there is no fluid flow measured by the flow meter (16) for a defined time interval, calculating a difference between the pipe temperatures measured by the first and second pipe temperature sensors (17a, 17b),
if the difference between the pipe temperatures differs more than a second threshold from a second reference value, and if there is no flow measured by the flow meter (16), then detect micro-leakage.

7. Method as claimed in claim 6, **characterized in that** the second reference value is determined as follows:

if there is no fluid flow measured for the defined time interval, then calculate and store the difference between the pipe temperatures measured by the first and second pipe temperature sensors (17a, 17b),
calculate an average value from the stored differences,
determine the second threshold from this average value.

8. Method as claimed in claim 7, **characterized in that** the average value is multiplied by a factor to determine the second reference value.

9. Method as claimed in one of claims 1 to 8, **characterized in that** the micro-leakage detection is ambient temperature independent.

10. Method as claimed in one of claims 1 to 8, **characterized by** the following steps:

measuring an ambient temperature by at least one ambient temperature sensor (18),
when there is no fluid flow measured by the flow meter (16) for a defined time interval, calculating a difference between the pipe temperature and the ambient temperature,
if the difference between the pipe temperature and the ambient temperature differs more than a third threshold from a third reference value, and if there is no flow measured by the flow meter (16), then detect micro-leakage.

11. Method as claimed in claim 10, **characterized in that**
the third reference value for the difference between the pipe temperature and the ambient temperature is determined as follows:

if there is no fluid flow measured for the defined time interval, then calculate and store the difference between the pipe temperature and the ambient temperature,
calculate an average value from the stored differences,
determine the third threshold from this average value.

12. Method as claimed in claim 11, **characterized in that**
the calculated difference is only stored and used to calculate the average value if the calculated difference is within a range around a previously calculated difference or within a range around an average value of previously stored differences.

13. Method as claimed in claim 11 or 12, **characterized in that** the average value is multiplied by a factor to determine the third reference value.

14. Apparatus (15) for micro-leakage detection in a fluid system, especially in a potable water system installed in a building, the apparatus having:

an interface (15a) being configured to receive a signal from a flow meter (16) measuring the fluid flow through a fluid pipe (12) of the fluid system,
an interface (15b) being configured to receive a signal from at least one pipe temperature sensor (17a, 17b) measuring the pipe temperature of the fluid pipe (12),
a processor (15d) being configured to detect micro-leakage by analyzing the pipe temperature when there is no fluid flow measured by the flow meter (16).

15. Apparatus as claimed in claim 14, **characterized in that** the same is configured to execute the method as claimed in one of claims 1 to 13.

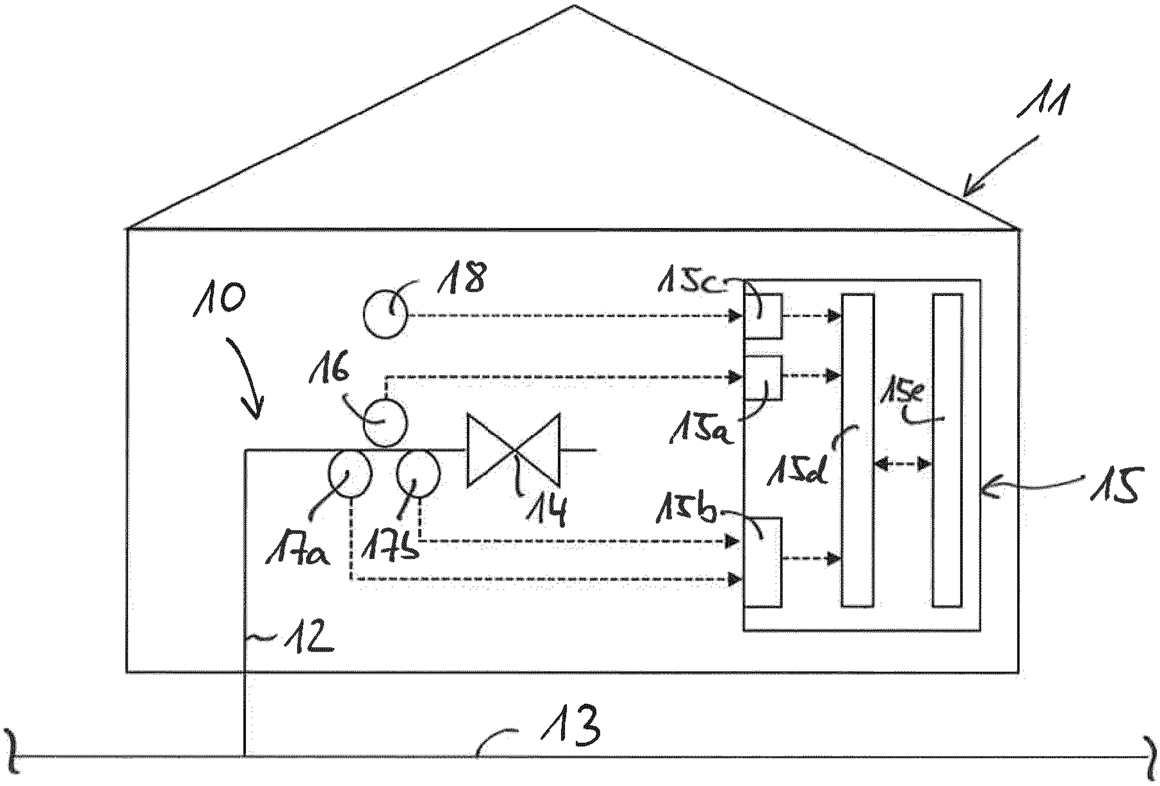
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Fig.1

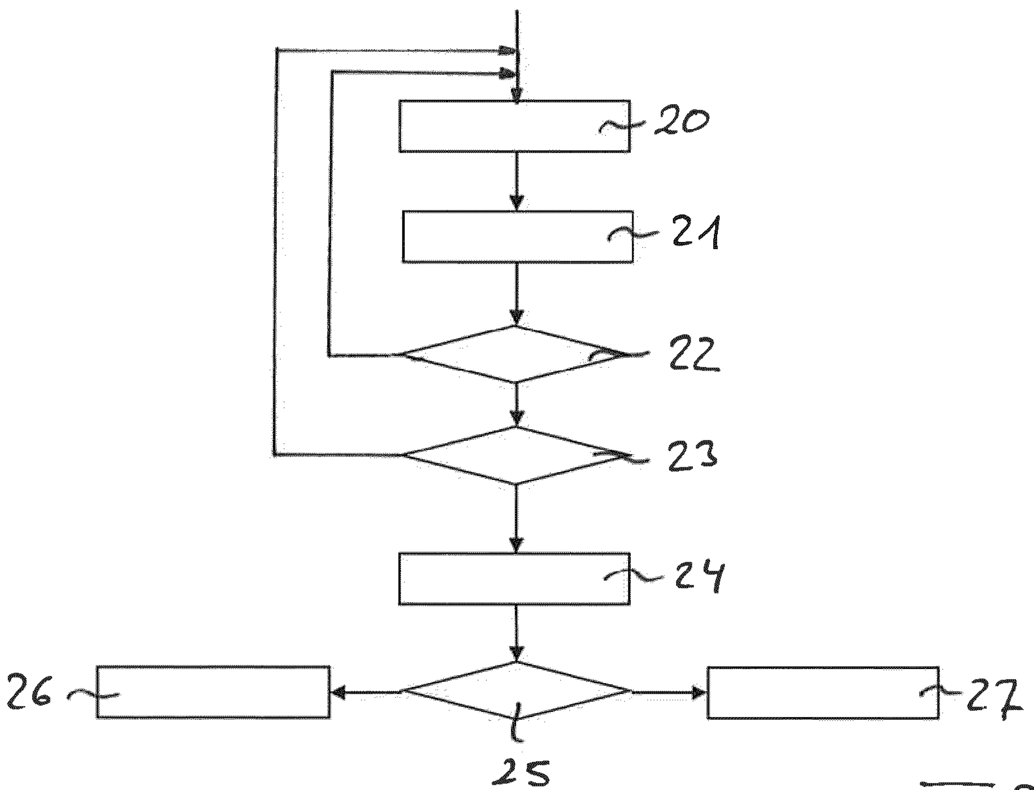
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Fig.2

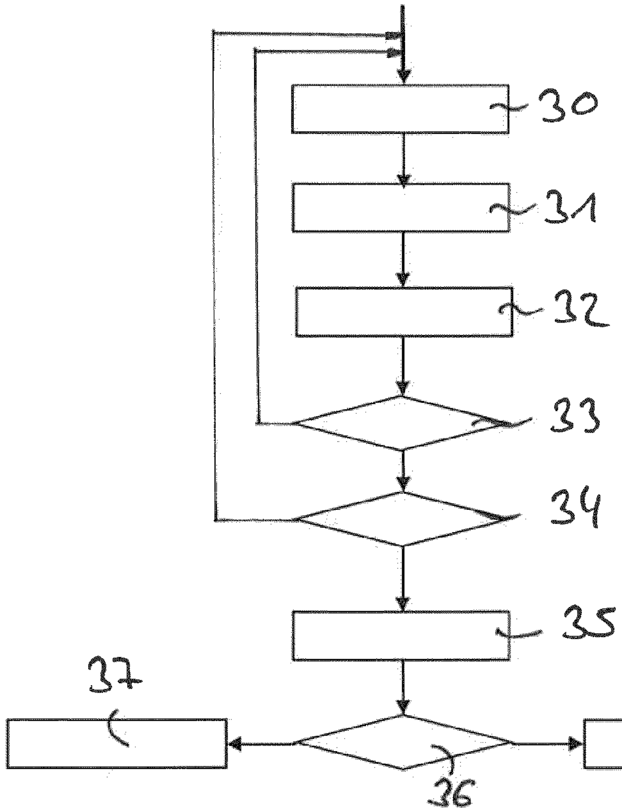

Fig.3

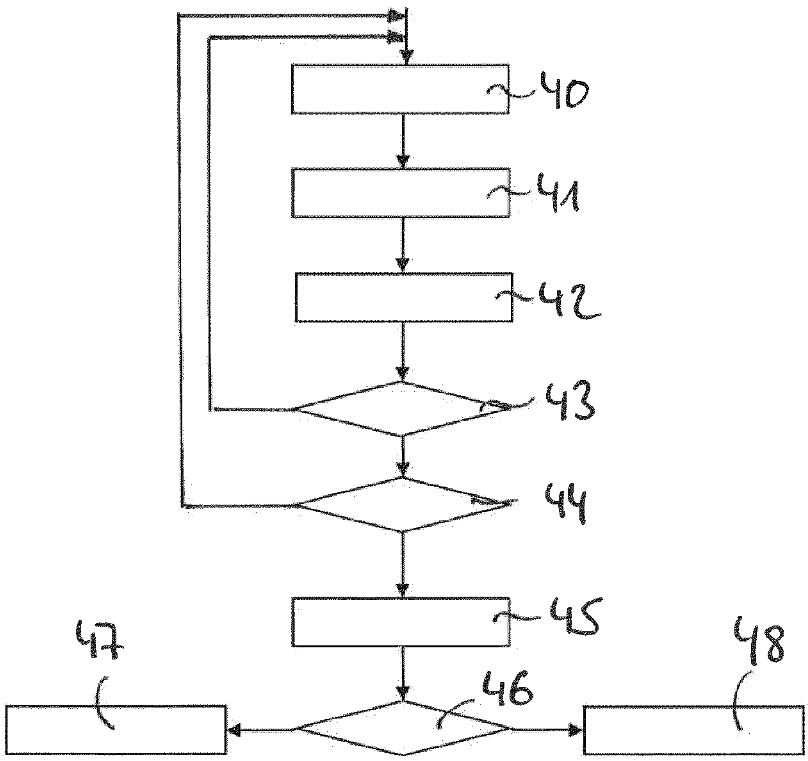

Fig.4

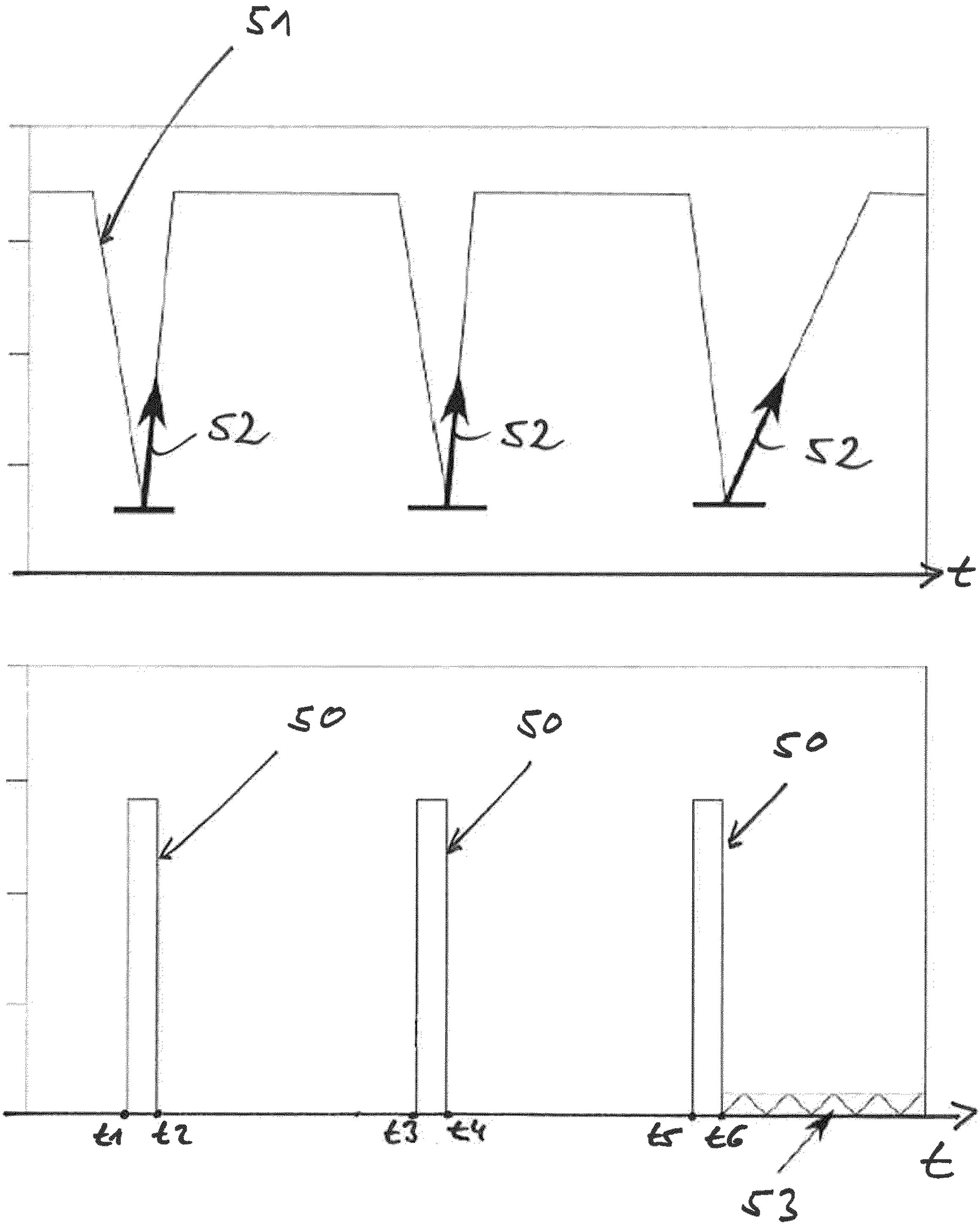

Fig.5

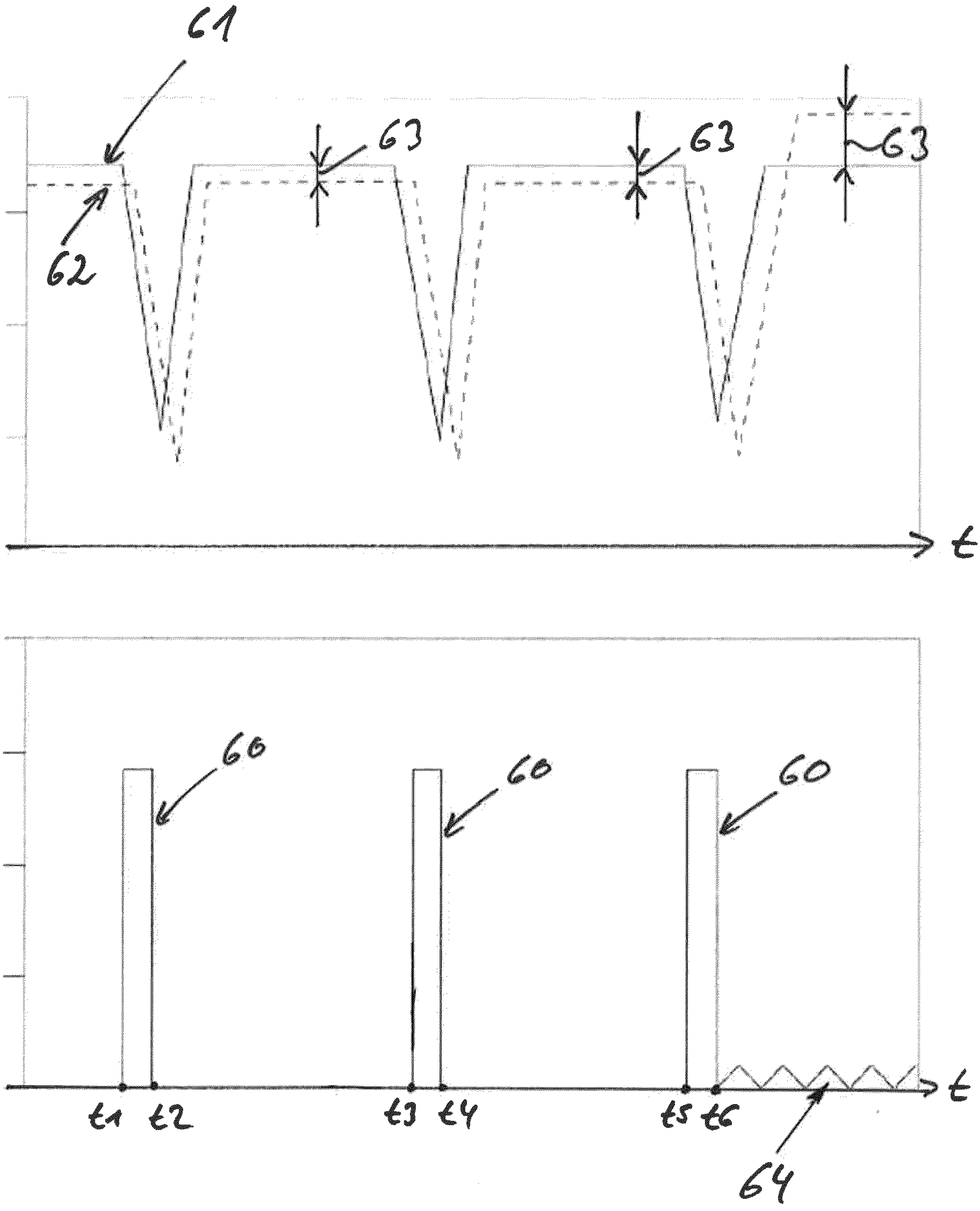

Fig. 6

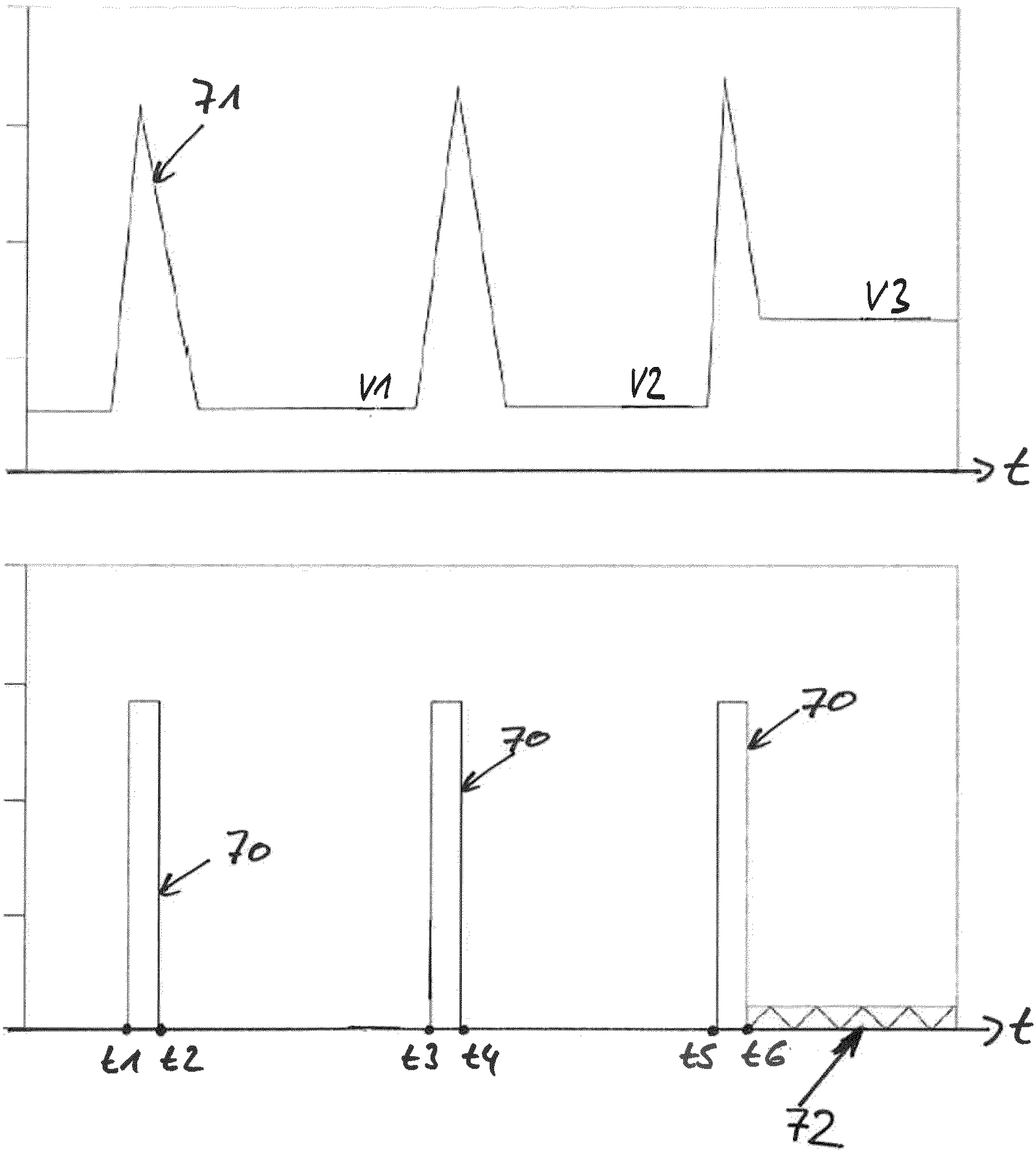

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 20 17 5432

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G01F
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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
The Hague	15 October 2020	Stavroulis, Stefanos

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